Indian J. Phys. **74B** (5), 337–339 (2000)

RAPID COMMUNICATION

I J P B
an international journal

Percentage contribution of different stratospheric compounds on depletion of Ozone at Antarctica

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[Communicated through Prof Sandip K Chakrabarti]

Received 30 May 2000, accepted 23 June 2000

Abstract . Dramatic decrease of O_3 concentration due to different chemicals is analysed critically Though concentration of CO_2 is maximum, analysis shows that percentage contribution of N_2O towards the destruction of O_3 at Antarctica is maximum Pi-chart for depletion of Anatarctic O_3 is offered

Keywords Antarctic O_3 depletion, stratospheric compound, greenhouse gas

PACS Nos. 92 60 e, 82 40 We, 92 70.j

1. Introduction

WMO bulletin [1] confirms the slow depletion of O_3 everywhere; but dramatic decrease of O_3 concentration takes place at Antarctica during spring time. Antarctic O_3 depletion was first reported by Farman *et al* [2] Afterwards, it was verified by different investigators throughout the world

Different theories are proposed for the dramatic decrease of O_3 concentration at Antarctica during spring time. These are as follows :

(i) Chemical theory :

There are different chemical reactions which are responsible for dramatic decrease of O_3 concentration at Antarctica.

(ii) Natural theory .

Natural phenomena associated with solar cycle are responsible for dramatic decrease of O_3 concentration at Antarctica.

(iii) Dynamical theory :

According to this theory, O_3 is not depleted but redistributed. As a result O_3 hole is created at Antarctica

The purpose of this paper is to find the contribution of different greenhouse gases to the dramatic decrease of O_3 concentration at Antarctica Analysis shows that percentage contribution of N_2O is maximum in the depletion process of O_3 In our calculation, we have considered CO_2, CH_4, CFC-11, CFC-12 and N_2O as depleting agents of O_3 at Antarctica.

2. Results and discussion

Concentration of CO_2 are recorded at South Pole [3] for long period Measurement of concentration of other greenhouse gases at South Pole are recorded for recent years [4–6] In order to obtain long period data of different greenhouse gases, we have calibrated the concentratioin of different greenhouse gases against CO_2. We have obtained perfect straight lines in each cases (Figure 1) and the equations are as follows :

$$CH_4 = 8.2519\ CO_2 - 1258, \quad (1)$$

$$CFC\text{-}11 = 6.0022\ CO_2 - 1855.70, \quad (2)$$

$$CFC\text{-}12 = 11\ 664\ CO_2 - 3635.80, \quad (3)$$

$$N_2O = 0.4745\ CO_2 + 142.49. \quad (4)$$

From the equations, long period data of CH_4, CFC-11, CFC-12 and N_2O are calculated. From the long period data

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of O_3 concentration at McMurdo station of Antarctica [7] (78^{0}S 166^{0}E), a scatter diagram is drawn against CO_2

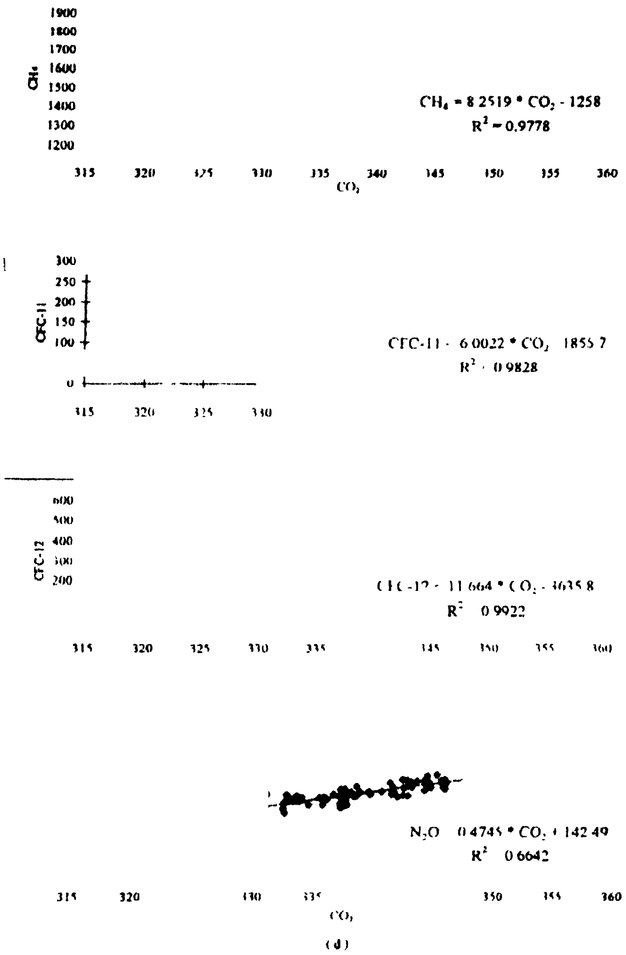

Figure 1. Calibration of concentration of different greenhouse gases with CO_2

(Figure 2) and the following best fitting equation is established.

$$O_3 = -2.1248\ CO_2 + 995.83. \tag{5}$$

Then by the same procedure, we obtained other equations for other O_3 depleting agents which are :

$$O_3 = -0.2575\ CH_4 + 671.87, \tag{6}$$

$$O_3 = -0.3558\ CFC\text{-}11 + 339.14, \tag{7}$$

$$O_3 = -0.1823\ CFC\text{-}12 + 333.52, \tag{8}$$

$$O_3 = -4.6995\ N_2O + 1700.20. \tag{9}$$

Climate of earth depends on radiative balance of the atmosphere, which in turn depends upon the input of solar radiation and atmospheric abundance of greenhouse gases, clouds and aerosols. Chemical composition of earth's atmosphere is changing largely due to human activities. Air trapped at Antarctic and Greenland ice shows that there has been major increase in the concentration of green house gases such as CO_2, CH_4, CFCs and N_2O.

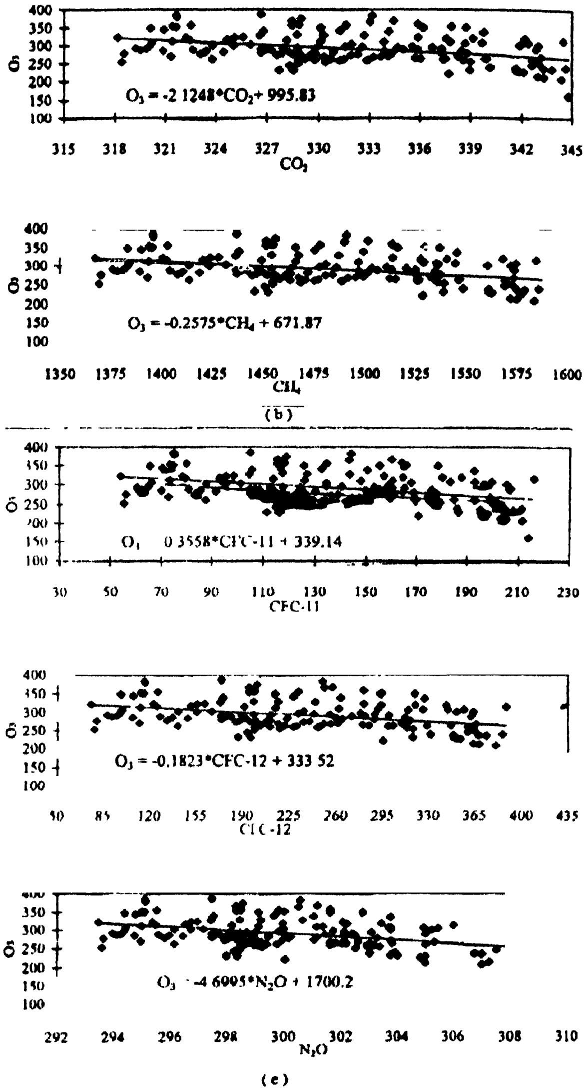

Figure 2. Scatter diagram of O_3 concentration against that of different O_3 depleting agents

Contribution of different chemicals towards O_3 depletion are calculated from eqs. (5–9) (Table 1). From the result,

Table 1. Percentage contribution of different chemicals for depletion of O_3 at Antarctic Survey station, McMurdo

Name of depleting agent	Rate of depletion	% Contribution in O_3 depletion
CO_2	$\frac{d(O_3)}{d(CO_2)} = -2.1248$	27.88
CH_4	$\frac{d(O_3)}{d(CH_4)} = -0.2575$	3.38
CFC-11	$\frac{d(O_3)}{d(CFC-11)} = -0.3558$	4.67
CFC-12	$\frac{d(O_3)}{d(CFC-12)} = -0.1823$	2.39
N_2O	$\frac{d(O_3)}{d(N_2O)} = -4.6995$	61.67

it is clear that though concentration of N_2O is less than that of CO_2, percentage contribution of N_2O for depletion of O_3 is very much greater than that of CO_2 and the result has been shown in the form of a pi-chart (Figure 3)

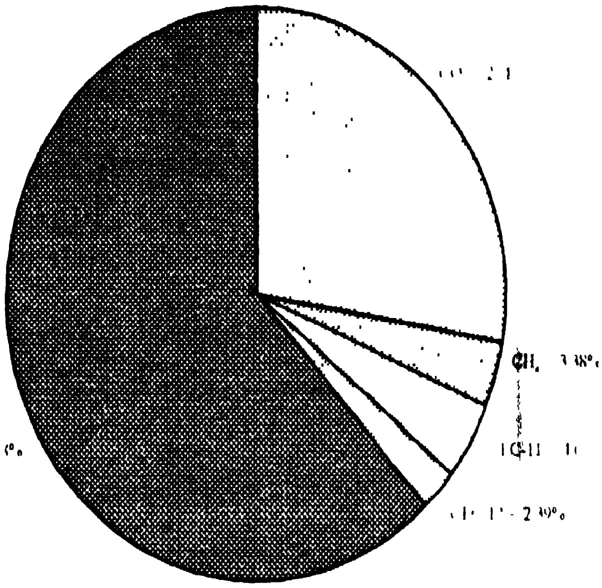

Figure 3. Pi-chart showing the percentage contribution of different greenhouse gases towards O_3 depletion

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